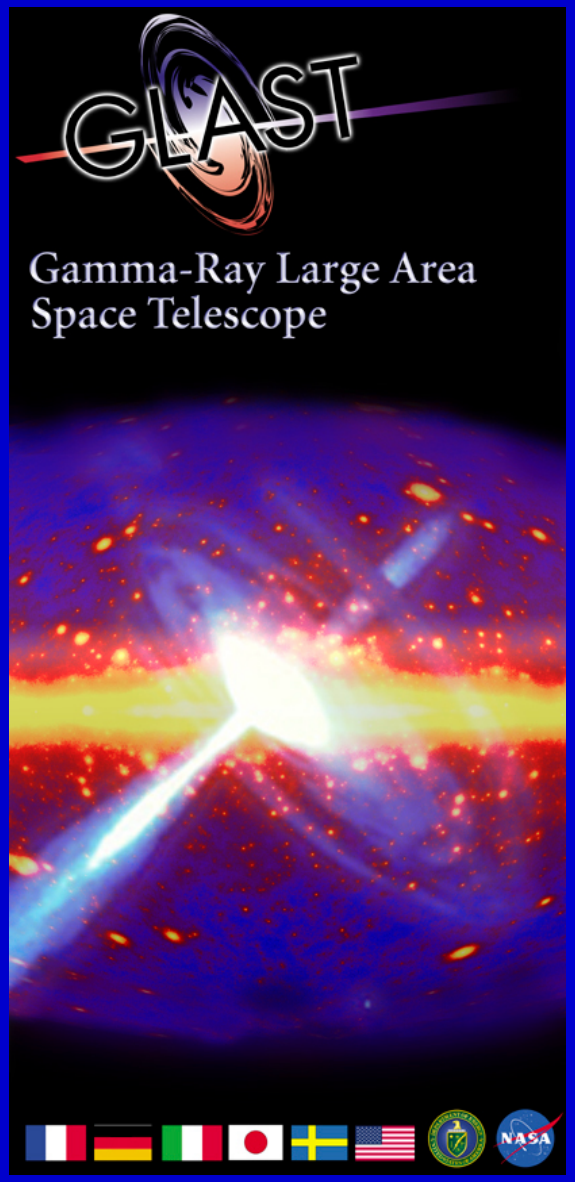
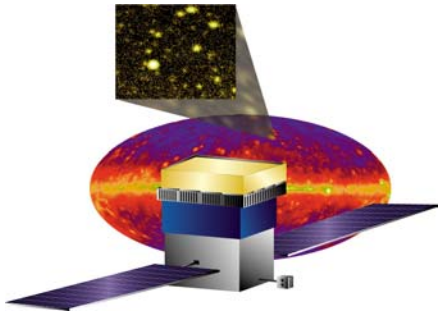


Gamma ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Balloon Flight Engineering Model (BFEM): Overview

David J. Thompson, NASA/GSFC
on behalf of the GLAST/LAT Collaboration

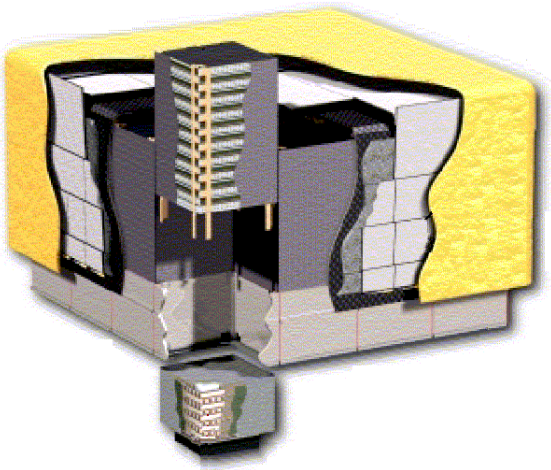


Outline

- What is GLAST?
- Why do this balloon test?
- What had to be done?
- Who is involved?
- How was it done?
- What was found?

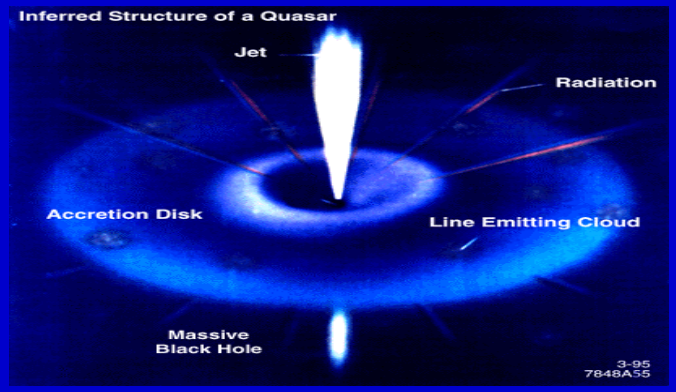
Gamma ray Large Area Space Telescope
GLAST

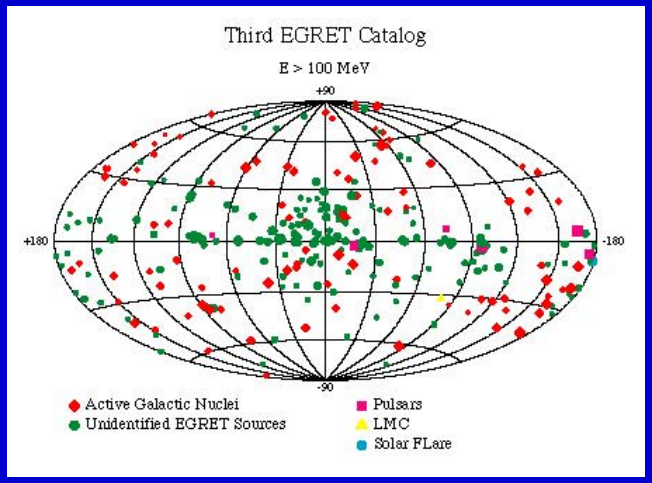

Credit: Hytec



- Intermediate-class observatory for gamma-ray observations, scheduled for 2006 launch
- Two instruments
  - **Large Area Telescope (LAT) - pair production telescope, E>10 MeV. 16 towers.**
  - GLAST Burst Monitor (GBM) - wide-field telescope for bursts, 10 keV - 30 MeV

GLAST Scientific Objectives



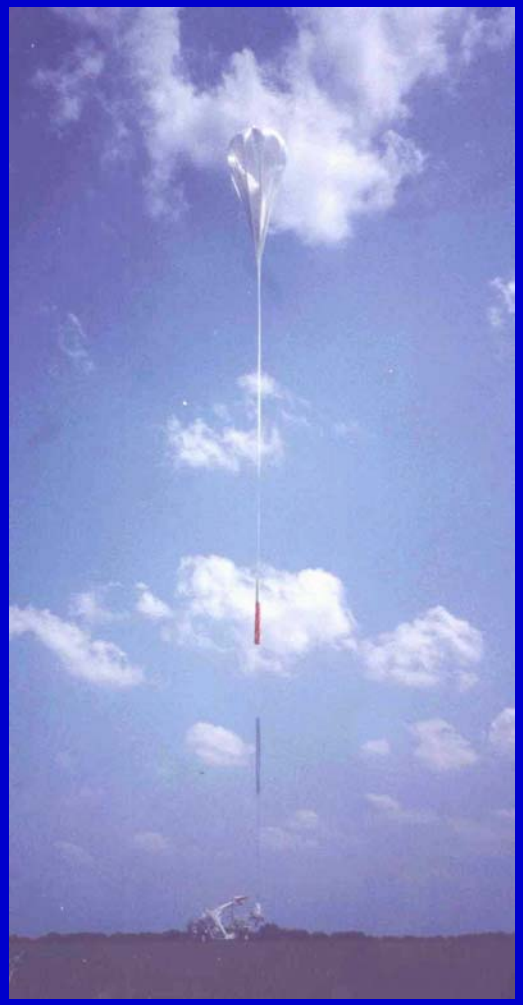


- Understand the mechanisms of particle acceleration in AGNs, pulsars, and SNRs.
- Resolve the gamma-ray sky: unidentified sources and diffuse emission.
- Determine the high-energy behavior of gamma-ray bursts and transients.
- Probe dark matter and the early Universe.

Why a Balloon Flight?

- **The LAT uses experimental techniques from high-energy physics (Si strip tracker and software trigger, for example) to improve greatly on previous high-energy telescopes like EGRET on the Compton Observatory.**
- **The key to success remains to separate the gamma rays from the high particle background in space.**
- **A balloon flight exposes a gamma-ray telescope to a near-space backround environment, including a mix of many particle types coming at high rate from all directions at random times.**
- **A successful balloon flight adds additional confidence to the simulations and beam tests already done.**

Goals of the Balloon Flight



- **Validate the basic LAT design at the single tower level in flight conditions.**
- **Show the ability to take data in the high isotropic background flux of energetic particles in the balloon environment.**
- **Record all or partial particle incidences in an unbiased way that can be used as a background event data base.**
- **Find an efficient data analysis chain that meets the requirement for the future Instrument Operation Center of the LAT.**

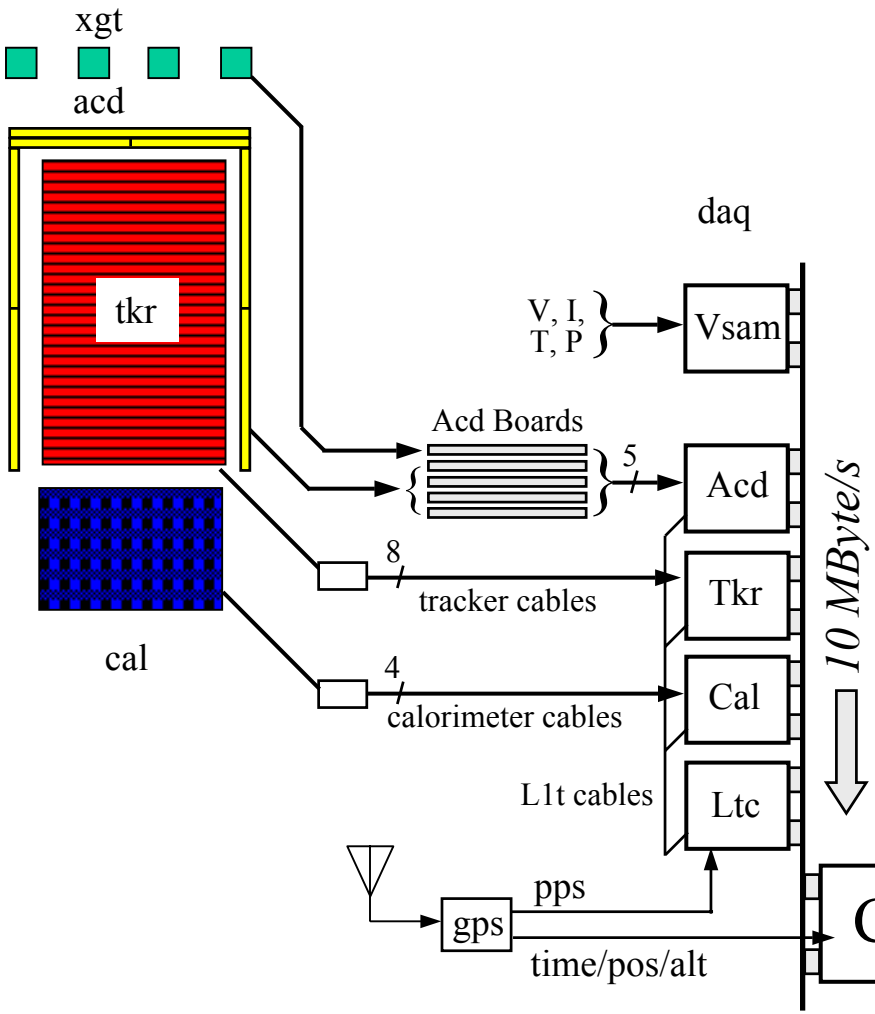
What Was Needed for this Balloon Flight?

- A LAT detector, as similar as possible to one tower of the flight instrument - functionally equivalent.
- Mechanical structure to support the instrument through launch, flight, and recovery.
- Power, commanding, and telemetry to make the instrument independent of hardware links to the ground.
- Real-time commanding and data displays.
- Data analysis tools.
- Modeling of the instrument response.
- IN ORDER TO BENEFIT THE FLIGHT EFFORT, THE BALLOON PROGRAM HAD TO BE DONE QUICKLY AND AT LOW COST.

Who Was Involved in this Balloon Flight?

- **D. J. Thompson, R. C. Hartman, H. Kelly, T. Kotani, J. Krizmanic, A. Moiseev, J. F. Ormes, S. Ritz, R. Schaefer, D. Sheppard, S. Singh,** ***NASA Goddard Space Flight Center***
- **G. Godfrey, E. do Couto e Silva, R. Dubois, B. Giebels, G. Haller, T. Handa, T. Kamae, A. Kavelaars, T. Linder, M. Ozaki, L. S. Rochester, F. M. Roterman, J. J. Russell, M. Sjogren, T. Usher, P. Valtersson, A. P. Waite,** ***Stanford Linear Accelerator Center***
- **S. M. Williams, D. Lauben, P. Michelson, P.L. Nolan, J. Wallace,** ***Stanford University***
- **T. Mizuno, Y. Fukazawa, K. Hirano, H. Mizushima, S. Ogata,** ***Hiroshima University***
- **J. E. Grove, J. Ampe, W. N. Johnson, M. Lovellette, B. Phlips, D. Wood,** ***Naval Research Laboratory***
- **H. f.-W. Sadrozinski, Stuart Briber, James Dann, M. Hirayama, R. P. Johnson, Steve Kliewer, W. Kroger, Joe Manildi,G. Paliaga, W. A. Rowe, T. Schalk, A. Webster,** ***University of California, Santa Cruz***
- **M. Kuss, N. Lumb, G. Spandre,** ***INFN-Pisa and University of Pisa***

Schematic of the Balloon Flight Engineering Model



Subsystems

xgt - External Gamma Telescope

acd - Anticoinence Detector

tkr - Tracker

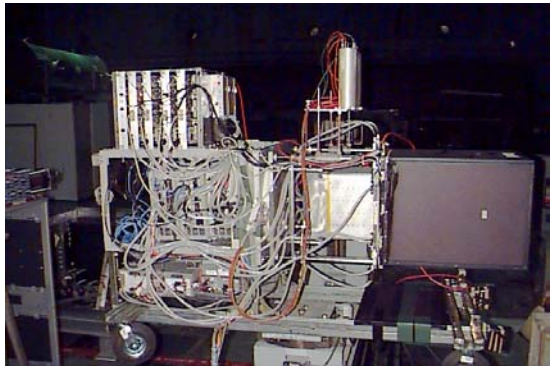
cal - Calorimeter

daq - Data Acquisition System

biu - Balloon Interface Unit

Lauben et al.poster at this meeting

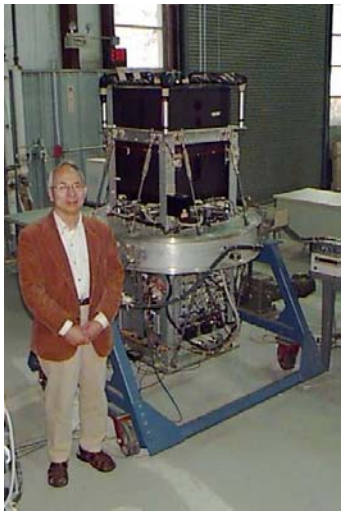
How Did We Build the Balloon Flight Engineering Model (BFEM)?



Existing Beam Test Engineering Model (BTEM) detectors

Support hardware borrowed from previous Goddard balloon projects

Modified BTEM electronics, new interface electronics, custom software



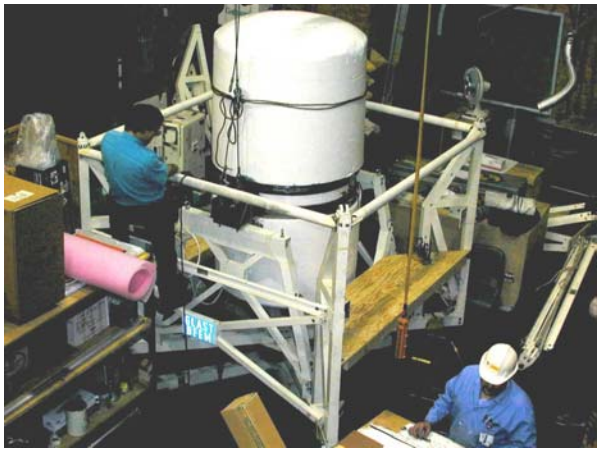
BFEM Assembled at Stanford Linear Accelerator Center (SLAC)

BFEM Integration and Test

Pressure vessel (borrowed)

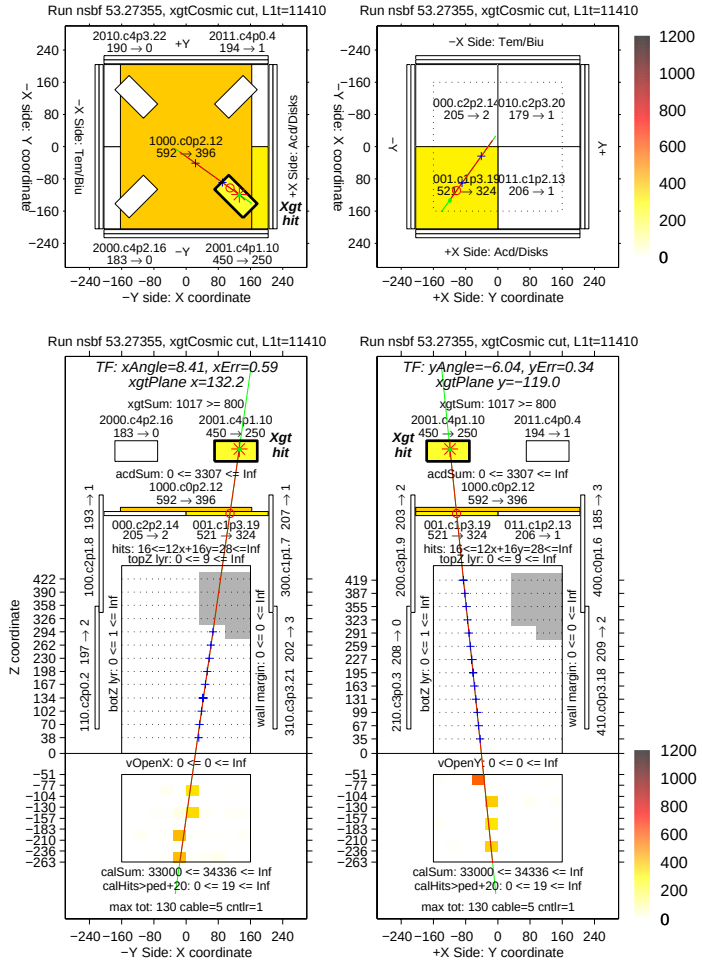
Gondola (borrowed)

Interface electronics and batteries



Integration at Goddard

Flight Preparations

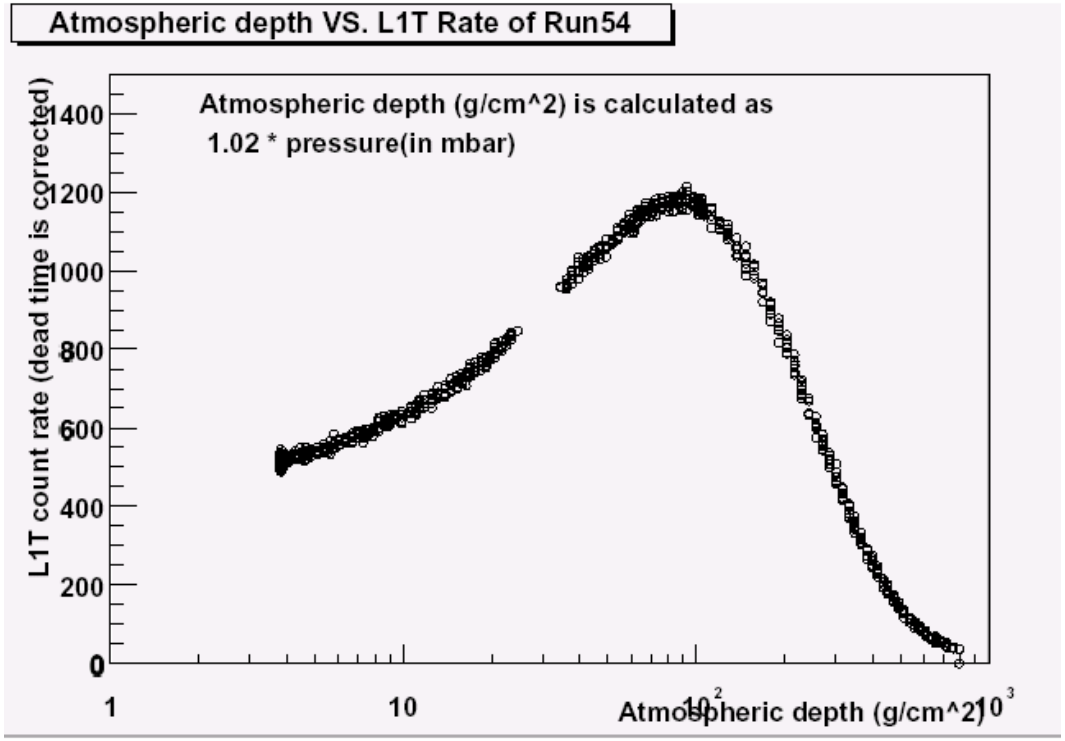


Real-time event display. A penetrating cosmic ray is seen in all the detectors.

Pre-launch testing at National Scientific Balloon Facility, Palestine, Texas. August, 2001.

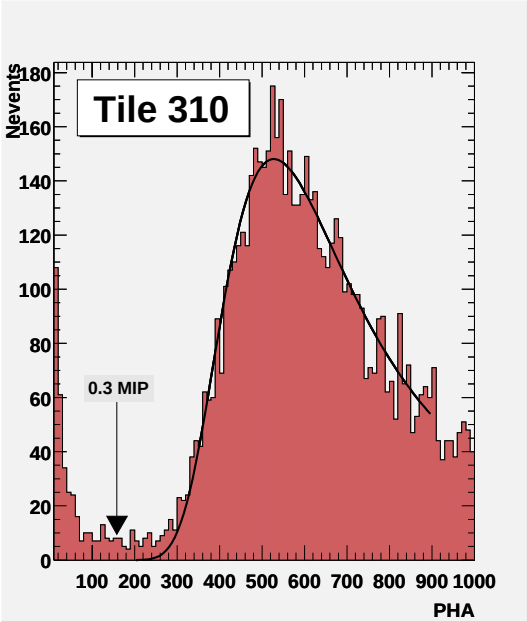
BFEM Flight - August 4, 2001

The balloon reached an altitude of 38 km and gave a float time of three hours.

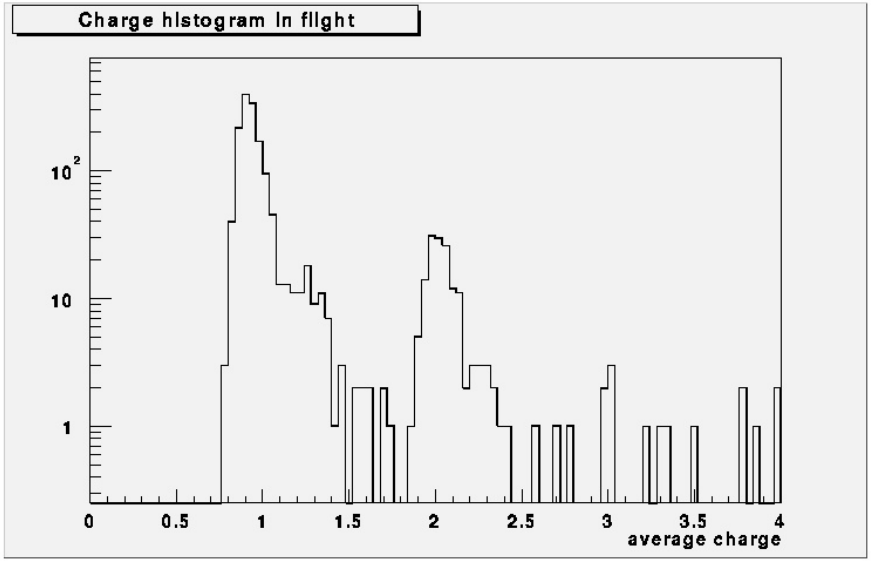


First results (real-time data): trigger rate as a function of atmospheric depth. The trigger rate never exceeded 1.5 KHz, well below the BFEM capability of 6 KHz. The gap in data resulted from a leak in the pressure vessel causing shutdown of onboard disks. Telemetry continued throughout the flight.

Balloon Flight Results - Subsystem Performance

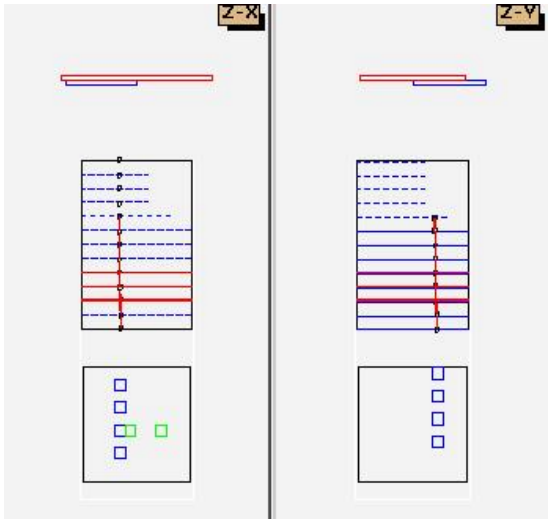


Anticoincidence Detector pulse height analysis for penetrating particles. The clean separation of the peak from the phototube noise shows that high efficiency is obtained.

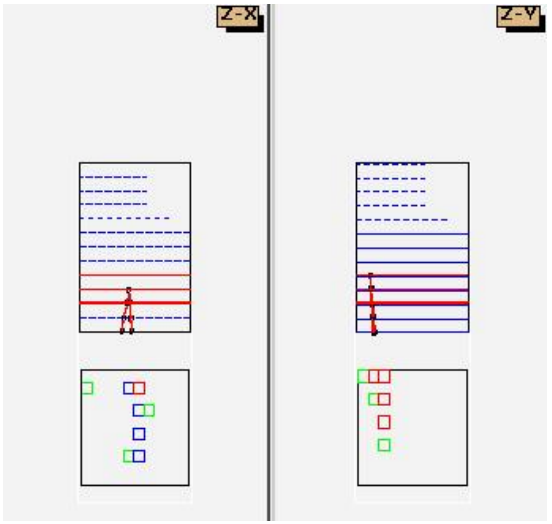


Charge histogram derived from pathlength-corrected total energy deposition in the Calorimeter. Both a single-charge peak and a peak due to alpha particles can be seen.

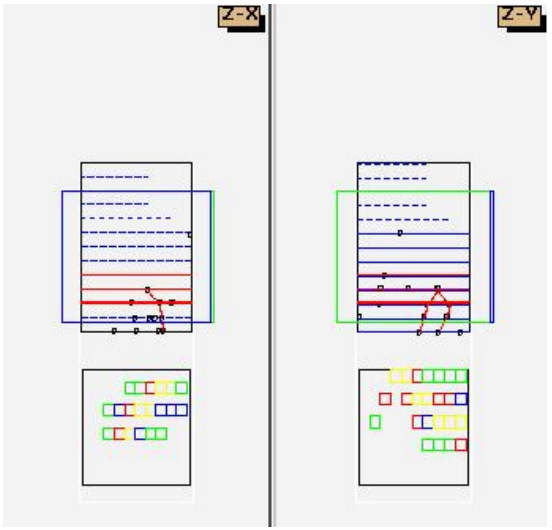
Balloon Flight Analysis - Sample Events



Single charged parrticle event. The track passes through the ACD (top), the tracker, and the calorimeter. The upper right corner of the tracker has no Si strips.



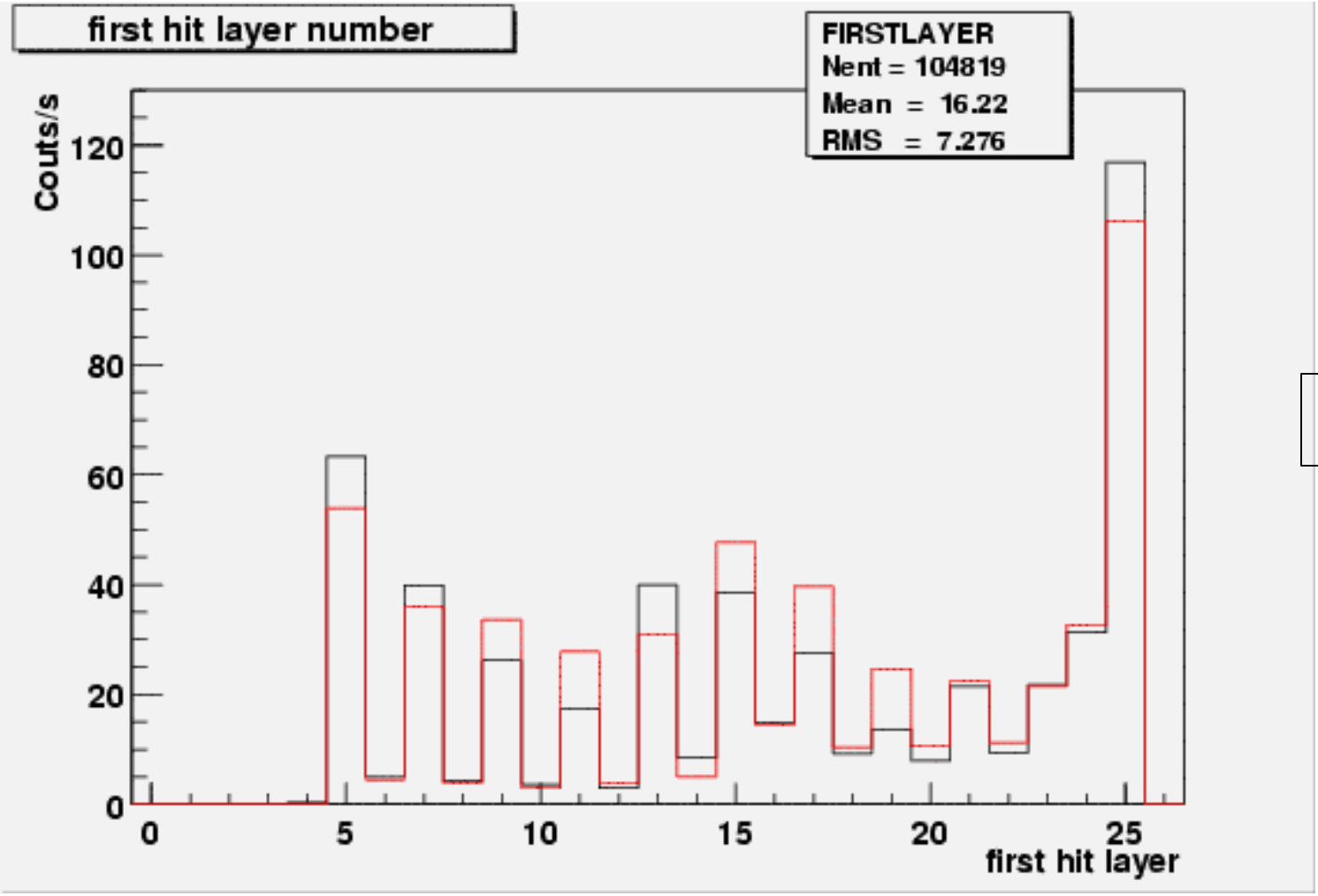
Gamma-ray pair production event. The two tracks are seen in the tracker and calorimeter. The ability of the recognition software to select such events demonstrates the data analysis capability.



A “difficult” event, with energy deposit in the ACD side panels, the tracker, and the calorimeter.

Do Couto e Silva et al. poster at this meeting.

Data vs. Simulation - Topmost Hit Layer in the Tracker



Sky

Mizuno et al. poster at this meeting

Conclusion - Meeting the Goals of the Balloon Flight

- **Validate the basic LAT design at the single tower level in flight conditions.**
- **All detectors worked well throughout the flight.**
- **Show the ability to take data in the high isotropic background flux of energetic particles in the balloon environment.**
- **The trigger and data handling system processed events under all conditions.**
- **Record all or partial particle incidences in an unbiased way that can be used as a background event data base.**
- **A variety of event types was seen, providing a reference data base.**
- **Find an efficient data analysis chain that meets the requirement for the future Instrument Operation Center of the LAT.**
- **The data analysis software successfully finds gamma-ray events. Work continues here.**